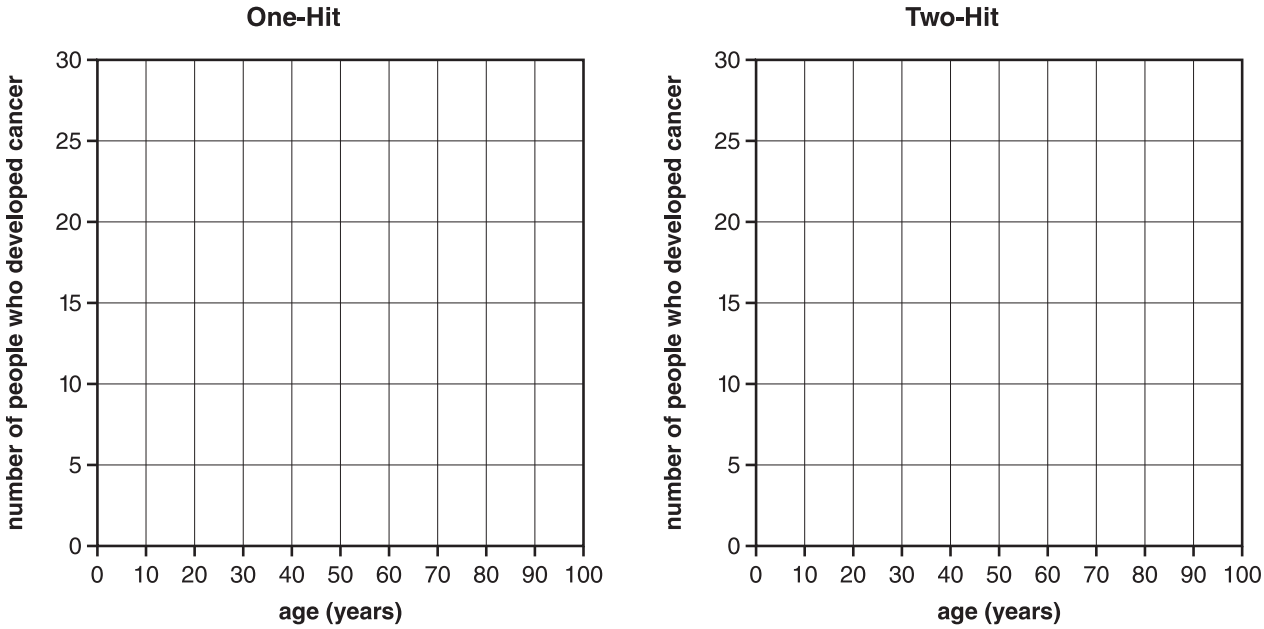
Collecting the Data

Age	Number of People Who Developed Cancer		Total Number of People Who Developed Cancer	
	One Hit	Two Hit	One Hit	Two Hit
5 years				
10 years				
15 years				
20 years				
25 years				
30 years				
35 years				
40 years				
45 years				
50 years				
55 years				
60 years				
65 years				
70 years				
75 years				
80 years				
85 years				
90 years				
95 years				
100 years				

Graphing the Data

Graph the class's results for the one-hit and two-hit hypotheses, then answer the question.



Do the one-hit and two-hit hypotheses provide good explanations for the incidence of colon cancer? Explain your answer.

Using the Hit Simulator

Follow the instructions below to use the Hit Simulator to test hypotheses about the development of cancer.

Conduct Your First Run

To familiarize yourself with the Hit Simulator, conduct a trial run as follows:

- Enter a "1" in the window labeled "number of hits required for cancer." This value means that you are testing the hypothesis that only one mutation is required for cancer to develop.
- Enter a "0.5" in the window labeled "mutation rate per age interval." This value means that you are testing the hypothesis that there is a 50 percent probability of experiencing a cancer-causing mutation at each age interval.
- Click the button labeled "Calculate Next 5 Years." The bar on the graph on the right side of the screen indicates the percentage of people in a population who would be expected to develop cancer by the age of 5 if the mutation rate were 50 percent and only one hit was required for a cell to become cancerous.
- Click the button labeled "Calculate to Age 100." The bars that appear on the graph indicate the percentage of people at each age interval who would be expected to develop cancer if the mutation rate were 50 percent and it required only one hit in order for a cell to become cancerous.

Investigate the Effect of Changing the Number of Hits Required

Use the Hit Simulator to investigate how the incidence of cancer in a population would be expected to change if different numbers of hits were required for a cell to become cancerous. For this investigation, keep the mutation rate set at 0.5 (50 percent). Conduct the runs indicated, then conduct three of your choice. Record your results in the following table.

Effect of Changing the Number of Hits Required

Number of Hits	Mutation Rate	Percentage of People Expected to Develop Cancer		
		By Age 25	By Age 60	By Age 80
1	0.5			
2	0.5			
5	0.5			
	0.5			
	0.5			
	0.5			

1. How does the incidence of cancer change as you require a greater number of hits for a cell to become cancerous?

2. Recall the graph of the incidence of colon cancer that you observed at the beginning of this activity. Did the incidence of cancer in any of the runs you just completed match the incidence of cancer recorded in that graph? Explain your answer.

3. What can you conclude from this observation?

Investigate the Effect of Changing the Mutation Rate

Use the Hit Simulator to investigate how the incidence of cancer in a population would be expected to change if the mutation rate were different. For this investigation, keep the number of hits required set at 1. Conduct the runs indicated, then conduct three of your choice. Record your results in the following table.

Effect of Changing the Mutation Rate

Number of Hits	Mutation Rate	Percentage of People Expected to Develop Cancer		
		By Age 25	By Age 60	By Age 80
1	0.1			
1	0.5			
1	1.0			
1				
1				
1				

4. How does the incidence of cancer change as the mutation rate increases?

5. Recall the graph of the incidence of colon cancer that you observed at the beginning of this activity. Did the incidence of cancer in any of the runs you just completed match the incidence of cancer recorded in that graph? Explain your answer.

6. What can you conclude from this observation?

Investigate the Effect of Changing
Both the Number of Hits Required and the Mutation Rate

Now use the Hit Simulator to investigate how the incidence of cancer in a population would be expected to change with different combinations of the number of hits required and mutation rates. Conduct the runs indicated, then conduct three of your choice. Record your results in the following table.

Effect of Changing Both the Number of Hits Required and the Mutation Rate

Number of Hits	Mutation Rate	Percentage of People Expected to Develop Cancer		
		By Age 25	By Age 60	By Age 80
1	0.1			
5	0.1			
7	0.1			
1	0.04			
5	0.04			
7	0.04			

7. What can you conclude from your observations?

Summary

8. What clue did the change in risk of colon cancer provide scientists about the cause of cancer?

Testing an Explanation by Looking at Additional Data

It sometimes happens that as scientists begin to explain one thing (for example, cancer as a multistep process), they find that they also can explain other observations. In fact, an idea's power to help us explain other things we've observed gives us new evidence that the idea may be correct.

Use your new understanding of cancer as a multistep process to explain the following observations.

1. ***Cancer is a disease of aging.*** "With a handful of exceptions, cancer is a disease of aging and is vastly more likely to strike in the middle or later years than in childhood, youth, or young adulthood. Indeed, experts unanimously cite age as the single most important risk factor [for cancer]."[1]

   Explanation:

2. ***You've come a long way, baby***. "[There was a] 20–25-year lag between the onset of widespread cigarette smoking among women after World War II [1945] and the massive increase in female lung cancer detected in the 1970s."[2]

   Explanation:

3. ***Genes and increased susceptibility.*** "If a woman carries this mutation [*BRCA1*], she faces . . . an [increased] risk—not a certainty—of developing breast cancer. . . . If a woman does not carry this mutation, her risk of breast cancer is . . . [lower]."[3]

   Explanation:

1 Murphy, G.P., Morris, L.B., & Lange, D. 1997. *Informed decisions.* Viking: The American Cancer Society.
2 Varmus, H., & Weinberg, R.A. 1993. *Genes and the biology of cancer.* New York: Scientific American Library.
3 Sidransky, D. 1996. Advances in cancer detection. *Scientific American, 275*(3): 104–109.